

MAKERERE



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COLLEGE OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

SCHOOL OF AGRICULTURAL SCIENCES

DEPARTMENT OF AGRIBUSINESS AND NATURAL RESOURCE ECONOMICS

**THE CAUSES OF POST-HARVEST LOSSES IN MAIZE AND THEIR EFFECTS ON
PROFITABILITY OF AGRIBUSINESS ENTERPRISES IN MASINDI DISTRICT**

A CASE STUDY OF MASINDI MUNICIPALITY

BY

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PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A
BACHELOR OF AGRIBUSINESS MANAGEMENT**

AUGUST 2016

DECLARATION

I **ATEGEKA STEWART** hereby declare that the content of this special project is all mine except where stated, and has never been submitted to Makerere University or any other institution of learning as a study piece or for any award

Signature.....

Date.....

APPROVAL

This special project has been submitted for approval by the university supervisor

Signature..... Date.....

(Prof. Arcihleo N. Kaaya)

DEDICATION

I dedicate this special project to my beloved mother, Mrs. Kiiza Grace, my dear father, Mr. Byaruhanga Wilson, as well as my entire family for the support and encouragement.

More dedication goes to Aunt Birungi Margret, all members of Chwezi fraternity and Kyedumira Foundation for their support towards making this study a success

I also dedicate it to my great friend Kiiza Modest for her tremendous effort in order to make this report possible. May the almighty God reward you all abundantly.

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LIST OF ABBREVIATIONS

APHLIS:	African Post-Harvest Loss Information System
EAC:	East African Community
EAS:	East African Standards
FAO:	Food And Agriculture Organization
MADFA:	Masindi District Farmers' Association
PHH:	Post-Harvest Handling
PHL:	Post-Harvest Loss
UBOS:	Uganda Bureau Of statistics
WFP:	World Food Program
WL:	Weight Loss
WHO:	World Health Organization

ABSTRACT

This special project was compiled after conducting research in Masindi Municipality on the causes of post-harvest losses and their effects on the profitability of agribusiness enterprises. The main objective was to assess the extent of post-harvest losses of maize and their impact on the profitability of agribusiness enterprises in Masindi Municipality.

The information attained in this report was collected mainly using direct interviews and questionnaires, mainly primary data was used.

A total of 50 maize farmers and 30 maize traders were interviewed using questionnaires. The specific objectives were to identify the different causes of post-harvest losses in maize, to establish the extent of the post-harvest losses in maize and to analyze the effects of post-harvest losses in maize on the profitability of agribusiness enterprises.

Results showed that the main causes of post-harvest losses among the maize farmers and traders were the mode used to transport maize, the type of storage facility, insects, rodents and molding. The gross margin analysis indicated that maize business is profitable with an average gross margin of Uganda shillings 8,297,837.5 per maize trader though still low.

The study recommends that the relevant authorities avail information on maize quality standards to the farmers and traders to increase their awareness, farmers to adopt the use of tarpaulins during maize harvesting, shelling and drying, the concerned stake-holders like Government to help farmers and traders improve the type of their storage facilities and also adopt the use of hermetic storage

CHAPTER ONE

1.0: INTRODUCTION

This chapter focuses on the background, problem statement, objectives, research questions, conceptual frame work and significance of the study.

1.1: Background

Uganda grows about 16 major food crops. These include Cereals (Maize, Millet, Sorghum, Rice); Root crops (Cassava, Sweet potatoes, potatoes); Pulses (Beans, Cow peas, Field peas, Pigeon peas); and Oil crops (Groundnuts, Soya beans, Sim sim), Plantains; and Coffee. (UBOS, 2014) However wheat is to be included in here because it has increasingly become a major crop in Uganda as it has been in rest of East Africa. (UBOS, 2014)

Maize was introduced in Uganda in 1861 (Balirwa, 1992) and by 1900 was already an established crop (Ministry of Agriculture 1988, quoted by Balirwa (1922)

Maize is widely grown in Uganda covering about 50 districts. The main production agro ecological zones are in the west, east, north and southeast Uganda. The crop is cultivated over 3.6 million households on about 1.5 million hectares of land. (UBOS, 2014). In terms of area planted, maize is the third crop after banana and beans. In some regions of the country, the crop has now become a staple food, replacing crops like sorghum, millet, cassava and bananas. It is a growing source of household income and foreign exchange through exports. For example maize is considered a major source of income in the districts of Masindi, Iganga, Kapchorwa, Mbale and Kasese. (UBOS, 2014). The national production of maize in 2009 was 2.4 million MT which came from an estimated area of 1 million hectares. (UBOS, 2010). Crop production contributes significant proportion of typical incomes in certain regions of the world (70 percent in Sub-Saharan Africa) and reducing food loss can directly increase the real incomes of the producers (World Bank, 2011).

Of recent, one of the main global challenges is how to ensure food security for a world growing Population whilst ensuring long-term sustainable development. According to FAO, (2013) food production will need to grow by 70% to feed world population which will reach 9 billion by

2050. Further trends like increasing urban population, shift of lifestyle and diet patterns of the rising middle class in emerging economies along with climate change put considerable pressure strain on the planet's resources, declining freshwater resources and biodiversity, loss of fertile land, etc. Consequently, there is a need for an integrated and innovative approach to the global effort of ensuring sustainable food production and consumption (Nellemann, 2009).

In the meantime, while the number of food insecure population remains unacceptably high (FAO, 2011), each year and worldwide, massive quantities of food are lost due to spoilage and infestations on the journey to consumers (FAO, 2011). In some African countries, where tropical weather and poorly developed infrastructure contribute to the problem, wastage can regularly be as high as 40-50% (SPORE, 2011). Obviously, one of the major ways of strengthening profitability of agribusiness enterprises is by reducing these losses.

Along the renewed focus on investment in agriculture that began in 2008, there is an increasing interest in effective intervention for Post-harvest losses (PHL) reduction. The investment required to reduce PHL is relatively modest and the return on that investment rises rapidly as the price of the commodity increases. (SPORE, 2011)

Action Contre la Faim (ACF) gives a particular attention to PHL reduction. During a research prioritization exercise undertaken by ACF Food Security and Livelihoods sector (FSL) in 2011, postharvest handling was recognized as one of the important areas requiring attention. It is of high importance in the effort to combat hunger, raise income thereby increasing the profitability of agribusiness enterprises. (Stuart, 2009). The term "postharvest loss" - PHL refers to measurable quantitative and qualitative food loss in the postharvest system (Boxall, 2002).

This system comprises interconnected activities from the time of harvest through crop processing, marketing and food preparation, to the final decision by the consumer to eat or discard the food. Interventions in PHL reduction are seen as an important component of the efforts of many agencies to reduce food insecurity. PHL is increasingly recognized as part of an integrated approach to realizing agriculture's full potential to meet the world's increasing food and energy needs. Therefore, reducing PHL along with making more effective uses of today's crops, improving productivity on existing farmland, and sustainably bringing additional acreage into production is critical to facing the challenge of feeding and increased world population, (WRAP, 2008).

As indicated by APHLIS (2012), post-harvest losses of maize in Uganda are averaged at 17.58% an annual volume loss of 215,243.13 metric tons. This implies that Ugandan maize farmers and traders lose a lot of revenue due to post-harvest losses which lowers the profitability of maize business.

This brief outline of the aspects of PHL reminds us that the post-harvest sector itself is part of a much broader and more complex system, in which the various types of interrelationship and interdependence concern not only the successive operations in the food chain, but also the whole range of human activities and hence the very workings of society, that need to be given special attention to ensure increased profitability of agribusiness enterprises. It is up on this background that the extent of post-harvest losses in maize in Masindi municipality needs to be established with regards to the profitability of agribusiness enterprises which this study looked at.

1.2: Problem statement

Many policy interventions have been done by the Government of Uganda and foreign agencies to improve agricultural productivity and maize productivity in particular for example producer oriented policy decisions like value chain development and consumer oriented policy decisions like food fortification (FAO, 2015). Research has also been done on the different causes of post-harvest losses and different recommendations have been suggested to overcome them (WFP, 2015)

Many stake-holders have come on board to improve post-harvest handling of maize in Masindi district through farmer sensitization on proper post-harvest handling techniques, innovations of promoting mobile shelling, establishment of model cribs in different sub-counties and construction of modern granaries, selection of village agents to help in delivering of modern post-harvest handling equipment such as tarpaulins and translation of post-harvest handling guidelines in the local languages like Runyakitara. These stake holders include Masindi District Farmers Association (MADFA), Masindi Seed And Grain Growers Limited and maize traders like Joseph Initiative (FCPMA, 2014)

As noted by Byabakama the District production officer Masindi in 2013, maize is an important crop in Masindi district with an average annual production of 60,000 to 70,000 metric tons and is

one of the main sources of income to farmers in Masindi district thus the need to control post-harvest losses. (<https://www.ugandardionetwork.com/story/poor-maize-hrvests-in-Maindi>)

Less has been done to establish the extent of the post-harvest losses towards the profitability of agribusiness enterprises in Masindi district. This has therefore prompted the researcher into finding out the causes of post-harvest losses in maize and their effects on the profitability of agribusiness enterprises in the district.

1.3: Objectives of the study

Overall objective

To assess the extent of postharvest losses of maize and their impact on the profitability of agribusiness enterprises in Masindi municipality

Specific objectives

1. To identify the different causes of post-harvest losses in maize in Masindi municipality
2. To establish the extent of post-harvest losses in maize
3. To analyze the effects of post-harvest losses on profitability of agribusiness enterprises in Masindi municipality

1.4: Research questions

1. What are the causes of post-harvest losses in maize?
2. What is the extent of post-harvest losses in maize?
3. What are the effects of post-harvest losses on profitability of agribusiness enterprises?

1.5: Significance

The research was focused on creating an analysis and a broad understanding of post-harvest losses in maize, the extent of the losses and their effects on profitability of agribusiness enterprises in Masindi municipality. This was to help in suggesting means of reducing the problem and assisting policy makers in formulating policies that are relevant to community of Masindi municipality in regards to profitable maize production.

The research is also to be a fundamental guide for planning and development of Masindi municipality and also attract more organizations to develop the area.

The results will also provide a basis for further research of the related topics

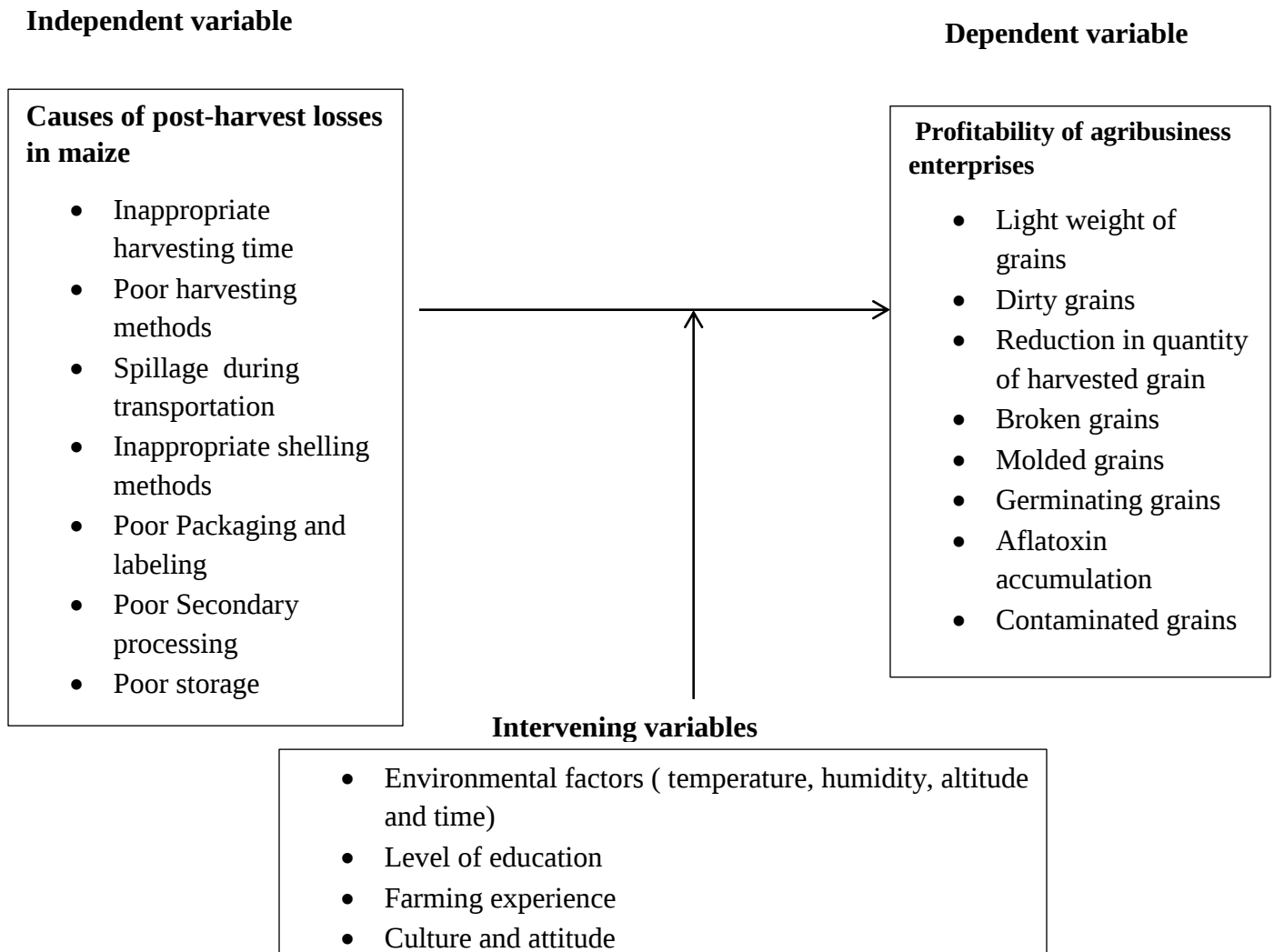


Figure 1: Conceptual framework

In this study, the variables and the conceptual framework were identified using many to one approach as narrated bellow.

The independent variables in the study were identified as the causes of post-harvest losses in maize whereas the dependent variable was profitability of agribusiness enterprises; these were in the form of;

Inappropriate harvesting time which involves harvesting of maize before the recommended harvesting time, this results into lightweight of grains after drying which lowers the expected profits from the produce.

Poor harvesting methods for example failure to heap the maize on tarpaulins during harvesting whereby harvested maize is collected on bare ground which makes it so dirty destroying its appearance therefore making it unattractive to the buyers. This in the end brings about less money being paid in exchange for such kind of maize leading to low profitability of agribusiness enterprises.

Spillage during transportation, as maize is transported from the garden to the cribs and from the cribs to the buyers or for processing, a lot of grain spills thereby reducing the actual quantity that was harvested which directly reduces the profits that would have been got from the sale of that maize.

Inappropriate shelling methods, many farmers cannot afford buying or hiring modern shelling machines. This makes them resort to beating of maize using sticks which breaks the grains thus lowering the quality of the maize leading to low gains from the sale of such maize resulting into low profitability of agribusiness enterprises in Masindi municipality.

Poor storage of maize, failure to safely store maize exposes the grains to insect attack, rodent attack and so many other organisms that lower the quality of the grains. This is always as a result of the poor storage facilities that in most cases do not have a good leak proof, good ventilation, vermin proof, well raised floor, good lock for security and for warehouses lack of pallets and failure to fumigate. A combination of these factors result into germination of the grains under storage, accumulation of aflatoxins, molding of grains, destruction of grains by vermins, rotting of grains, theft of grain, and insect attack. All these lower the quality of the maize hence reducing the profits that would have been got from the sales leading to low profitability of agribusiness enterprises.

Not only that, but there were also other intervening variables between the two variables identified, these included;

Environmental factors, weather extremes such as floods cause direct post-harvest losses in maize which reduces the profitability of agribusiness enterprises.

Level of education; Where maize handlers have low levels of education or are less informed about the appropriate post-harvest handling of maize increases post-harvest losses of maize leading to low profitability of agribusiness enterprises.

Farming experience, farmers and maize handlers who haven't been in the maize business for a good period of time usually have low background information on the proper post-harvest handling of maize which increases post-harvest losses leading to low profitability of agribusiness enterprises.

Culture and attitude, farmers and maize handlers who have a bad attitude towards adopting better post-harvest handling methods or whose cultures do not permit them to adopt better ways of handling maize usually expose their maize to high risks of post-harvest losses which directly leads to low profitability of agribusiness enterprises.

CHAPTER TWO

2.0: LITERATURE REVIEW

2.1: Post-harvest losses

Post-harvest losses according to Zorya, (2011) are classified into three main categories; quantitative loss, qualitative loss, and economic or commercial loss. Others classified as direct and indirect losses.

Quantitative loss indicates the reduction in physical weight, and can be readily quantified and valued, example a portion of grain damage by pests or lost during transportation. A qualitative loss is contamination of grain by molds and includes loss in nutritional quality, edibility, consumer acceptability of the products and the caloric value (Zorya, 2011).

Economic loss is the reduction in monetary value of the product due to a reduction in quality and or/ quantity of food (Tefera, 2012).

Postharvest losses can also be defined as the degradation in both quantity and quality of a food production from harvest to consumption. Quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. These losses are generally more common in developed countries. (Kader, 2010). Quantity losses refer to those that result in the loss of the amount of a product. Loss of quantity is more common in developing countries (Kitinoja and Gorny, 2010). A recent FAO report indicates that at global level, volumes of lost and wasted food in high income regions are higher in downstream phases of the food chain, but just the opposite in low-income regions where more food is lost and wasted in upstream phases (FAO, 2013).

Weight loss

Weight loss (WL) is the standard international measure of grain loss, generally regarded as a loss of food. WL is expressed as a loss in the dry matter or dry weight basis (Tefera, 2011). According to APHLIS, (2014) WL is estimated in two ways; first, scattering of grain due to poor post-harvesting handling practices includes harvesting, threshing, drying, poor packaging and transport. Second, from biodeterioration brought by pest organisms such as; insects, molds, and

fungi, rodents and birds (Hodges, 2013)). The weight loss can be calculated by the count and weight method (Eqn.1) developed by Adams and Schulten (1978). Other methods include standard volume and weight method (SVM) equation 2 (Reed, 1987) and by the thousand grain mass (TGM) equation 3 and converted percentage damage method (Dick, 1988).

$$\text{Percentage Weight loss (\%)} = \frac{(W_u \times N_d) - (W_d \times N_u)}{W_u \times (N_d + N_u)} \times 100 \dots\dots\dots (1)$$

Where;

W_u = Weight of undamaged grain

N_u = Number of undamaged grain

W_d = Weight of damaged grain

N_d = Number of damaged grain

$$\text{Percentage weight loss (\%)} = \frac{\text{Initial dry weight} - \text{Final dry weight}}{\text{Initial dry weight}} \times 100 \dots\dots\dots (2)$$

$$\text{Percentage weight loss (\%)} = \frac{M_1 - M_x}{M_1} \times 100 \dots\dots\dots (3)$$

Where;

M_1 = Grain mass before attack

M_x = Grain mass after attack

Mass = Dry matter weight

2.2: Agricultural crops losses

Losses are a measurable reduction in foodstuffs and may affect either quantity or quality. They arise from the fact that freshly harvested agricultural produce is a living thing that breathes and undergoes changes during postharvest handling.

Loss should not be confused with damage, which is the visible sign of deterioration, for example, chewed grain and can only be partial. Damage restricts the use of a product, whereas

loss makes its use impossible. Losses of quantity (weight or volume) and quality (altered physical condition or characteristics) can occur at any stage in the postharvest chain (ACF, 2014)

2.3: Food Losses and Food Waste

2.3.1: Food losses

Food losses refer to the decrease in edible food mass (dry matter) or nutritional value (quality) of food that was originally intended for human consumption (FAO, 2013). Food losses take place at production, postharvest and processing stages in the food supply chain. Food losses are mainly due to poor infrastructure and logistics, lack of technology, insufficient skills, knowledge and management capacity of supply chain actors, and lack to markets. (Parfitt et al., 2010)

2.3.2: Food waste

Food waste refers to food appropriate for human consumption being discarded, whether or not after it is kept beyond its expiry date or left to spoil. Food waste occurs at the food chain (retail and final consumption) and relates to retailers' and consumers' behavior. (Hodges, 2011).

Food wastage refers to any food lost by deterioration or waste. The term “wastage” includes food loss and food waste

Food waste or loss is measured only for products that are directed to human consumption, excluding feed and parts of products which are not edible. As defined by (Hodges et al, 2011). Food waste is the subset of food loss that is potentially recoverable for human consumption. Therefore, food that was originally meant to human consumption but which gets out the human food chain is considered as food loss or wastes even if it is then directed to a non-food use (feed, bioenergy, etc.). This approach distinguishes “planned non-food uses and “unplanned” non-food uses, which are hereby accounted under losses (FAO, 2011).

2.4: Post-harvest losses of maize at different stages.

For the development of a consistent methodology for the assessment of post-harvest losses (PHL) of food commodities, it is necessary to understand the concepts of loss. There is wide

range of variations adopted by researches. This can be attributed to the complexity and variability of all the post-harvest operations involved in the movement of food from harvest to fork. (Jaspreet et al, 2014) The best way to understand the theoretical or conceptual model is to understand steps which comprise of the post-harvest operations.

Food travels along the value chain from harvesting to consumption. Losses occur at each stage along the chain and contribute to total PHL. The loss at each stage is driven by different factors, examples of which are described in Figure 2. The relative importance of a particular stage or factor toward contributing to total PHL will vary across countries and commodities. For example, estimating losses for a sophisticated, vertically integrated chain will likely require consideration of fewer factors than for a less integrated chain where the commodity undergoes several transactions before reaching the retail outlet. (Hodges et al. 2011). Therefore while the conceptual framework is the same across all countries and commodities, the actual econometric model used for PHL will vary across countries and commodities. Food leaves the field by the process of harvesting, where mature crops are gathered from the fields. Harvesting methods can vary from most-labor intensive on small farms to most expensive and sophisticated farm machinery, like the combine harvester. There are also other external factors which affect the amount and quality of food harvested from the field. On a broad base, food products can be divided into two main categories- perishable and non-perishable. (TECA, 2012)

Perishable commodities comprise of food products which last only for short periods of time such as a few days to weeks. e.g. - milk, meat, fish, fruits, tuber and vegetables etc. On the other hand non-perishables have longer shelf life lasting from months to years, for e.g. cereals, rice, lentils, and dried fruits. Different food groups vary in the way they are harvested from the field. For perishable food groups the process consists of plucking and storing in boxes or bags but in case of non-perishables such as cereals additional steps such as threshing and cleaning are required (Hodge et al, 2011)

Jaspreet et al, (2014) described a conceptual model that can be used to analyze post-harvest losses in grains at different levels of the supply chain flow. Figure 2.

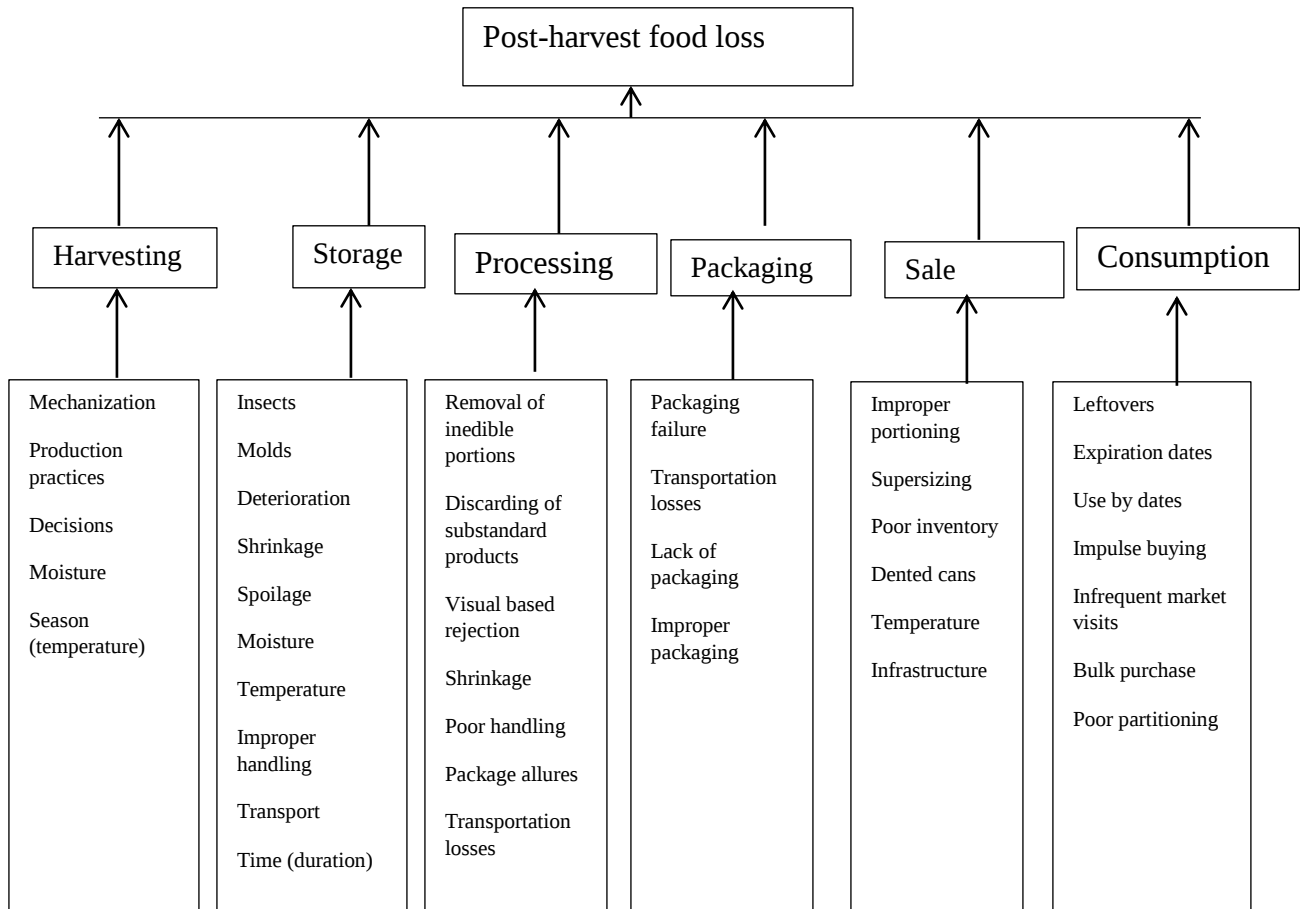


Figure 2: Conceptual model in post-harvest loss estimation. Source (Jaspreet , 2014)

For statistical estimation work, the total PHL at any post-harvest stage for a given commodity and region is the sum total of food losses occurring at each of stage of the process. (Jaspreet ,2014)

Total PHL = Sum of PHL at each stage of the food supply chain

$$\text{Total PHL} = \sum s_i = \sum f(x_j) \dots\dots\dots(4)$$

Where ‘s_i’ stands for the losses in each critical stage of FSC (Food Supply Chain);

‘x_j’ stands for the factors affecting losses at each step and ‘i’ represents critical stages from harvesting to sales.

$$S_i = \sum f(x_j) \dots\dots\dots(5)$$

The equation (5) on the right hand side represents post-harvest losses at particular stage in the food supply channel and on the left hand side represents all the measurable factors which contribute to these losses. Food losses at the different stages represented in Figure 2 can further be represented in a functional form as follows.

Losses at harvesting given by,

$PHL_{SH} = f$ (agroclimatic factors, farm and farmer related factors, level of mechanization, and credit availability).

Losses in storage is given by,

$PHL_{SS} = f$ (agro climatic factors, farm and farmer related factors, length of storage, distance to storage, quality of storage, and credit availability).

Losses during processing given by,

$PHL_{SP} = f$ (agro climatic factors, processing plant related factors, quality of supply chain, use of standards and grading, and credit availability).

Losses during packaging are given by

$PHL_{SPK} = f$ (agroclimatic factors, firm and operator related factors, quality of packaging, transportation, and credit availability).

Finally losses during sales are given by,

$PH_{SQ} = f$ (agroclimatic factors, retail outlet and manager related factors, quality of logistics and inventory control, and credit availability).

2.5: Maize value chain in Uganda

Due to the importance of maize in Uganda, several studies of marketing, transaction costs and value chain analysis are available. (USAID, 2010). The description provided here is mainly focused on market assessment of staple foods in Uganda,

According to studies by World Bank (2009) and PMA (2009). , the transactions involved in the marketing of maize are complex but the main channels for the commodity flow include (i) from farmer (farm gate) to agents/traders/village markets in rural areas; (ii) from rural markets to secondary markets in regional towns such as Iganga, Bugiri and Sironko; (iii) from urban markets to major buying centers outside the district and (iv) the export market. Each one of these channels involves a number of key players. Figure 3 depicts the typical maize supply chain in Uganda.

Rural agents are the main buyers of all maize traded in the sub-counties (smaller administrative units in the districts). (PMA, 2009) Their main function is to buy and/or assemble maize from

the numerous scattered farmers, often located in inaccessible rural areas. They find market for the maize (often the urban traders and processors) when they have accumulated sufficient quantities. The urban traders and processors arrange transport to collect the maize either directly from the farmers whom they pay on a cash basis, or from the collection points of the agents. Since the agents live in the rural areas, they are a reliable linkage between the farmers and urban traders and processors/millers. Urban traders are found in major centers in maize producing districts. (USAID, 2010). Their main activities include networking with rural agents, serving as a market outlet for farmers, and collecting maize grain before selling it to the various clients, including institutions and processors, located in the districts. Urban traders are also sources of bagging materials (sacks) used by farmers as well as market information in their areas of operation. Urban traders sell their maize mostly to millers. (USAID, 2010)

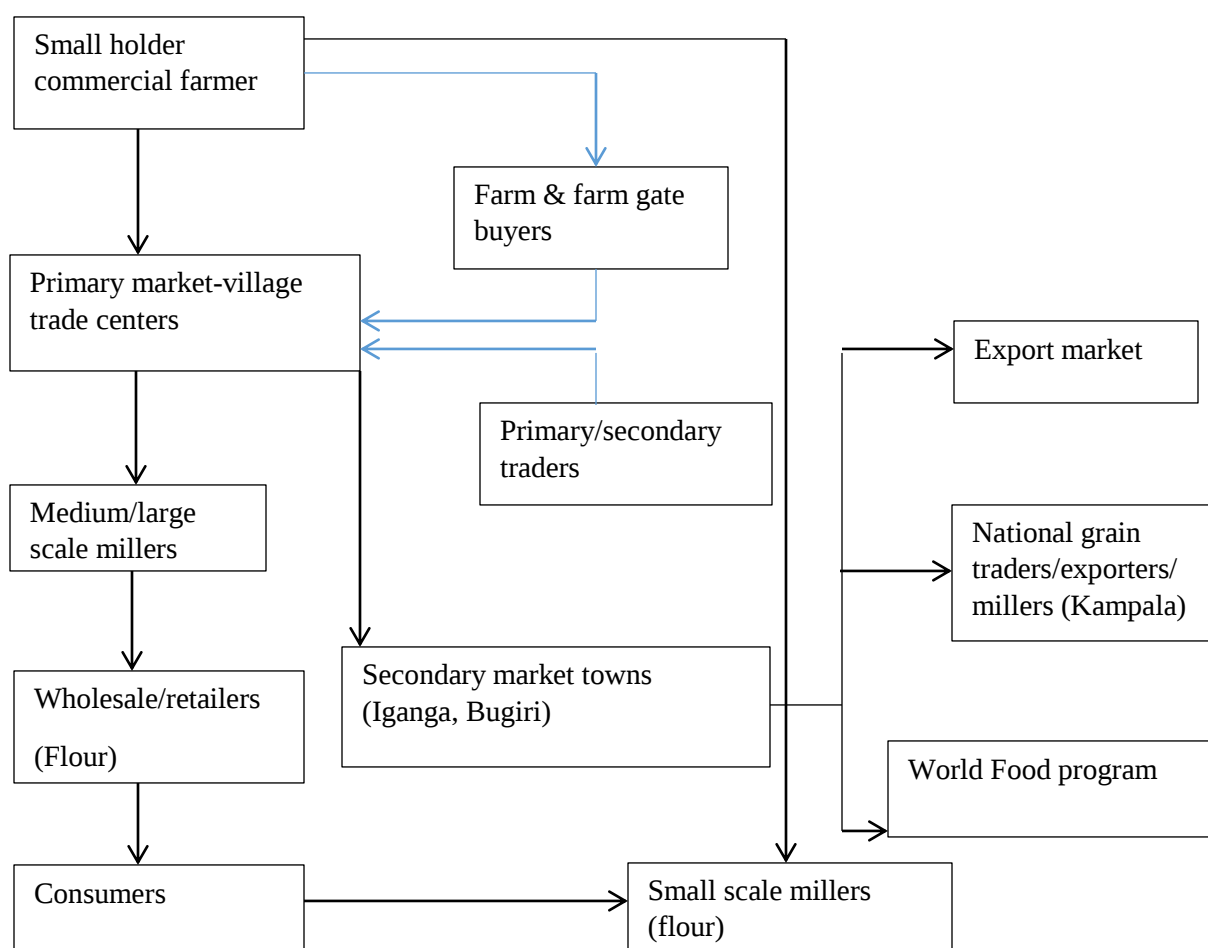


Figure 3: Typical supply chain for maize in Uganda

Source: Adapted from USAID (2010) and PMA (2009), World Bank (2009).

Maize grown and traded undergoes some level of value addition, conversion of maize grain into flour and a variety of other by-products, such as bran and germ. The principle players in this value chain are the processors/millers, grouped into three categories, namely: small-scale millers, medium scale millers and large-scale millers. Majority of the processors/millers fall under the small-scale category and they are scattered in various rural trading centers in the districts, carrying out primarily customized milling. Processing costs range from U Sh 50 to 100 per kg, depending on the location. (MAFAP, 2012)

The medium-scale processors are based in the main town centers – the district capitals and offer both contract and trade-based milling services to institutions and urban traders. The medium-scale millers first hull the maize to remove bran and then produce “No.1” flour, which is not very nutritious. The medium-scale millers charge a price of U Sh 70-100 per kg for milling. For every 100 kg of maize grain, about 70-73 kg of No.1 maize flour is produced. The millers sell the No.1 flour at USh 1000-1500 to wholesalers and retailers. The normal price of maize bran is U Sh 100 per kg to poultry and animal farmers and manufacturers of feed meals. (USAID, 2010)

Large-scale processors are only found in Kampala. They buy their maize from urban traders and large-scale traders from the western, central and eastern regions. They sell more than three quarters (75 percent) of their maize products to the World Food Programme (WFP) for export and distribution to war displaced people in Northern Uganda. The processors carry out activities such as cleaning, de-stoning, drying, fumigating and milling into flour. (MAFAP, 2012)

Transport costs are the major marketing cost and, therefore, are key in determining the prices offered to farmers by rural traders. The relative share of transportation cost in total marketing costs averages 84 percent in Uganda (World Bank, 2009). These costs are quite high because a maize bag often goes through a number of markets before reaching the final consumer in large cities and thus requires loading and unloading at each intermediate stop. For sales, maize is brought from farm to primary markets mainly by traders but sometimes by farmers themselves. The common mode of transportation on this route is either bicycle or carts. In Uganda, a 10MT truck is the mostly common mode of transportation beginning already from the rural market, while some traders use trucks with a capacity of between 24 and 32 metric tons (World Bank,

2009). Average distances between market pairs are short and the average distance between secondary and wholesale markets is about 80 km Uganda (from Jinja to Kampala)

A number of large scale traders and exporters of maize have emerged over the years. The main ones include: (i) the World Food Program, (ii) the Uganda Grain Traders (UGT), (iii) the Masindi Seed and Grain Growers Association (MSGGA), and (iv) the Uganda National Farmers Federation (UNFFE). (MAFAP, 2012)

The informal export market to Kenya is uncontrolled and involves the sale of low and variable quality maize. (MAFAP, 2012). This constrains the penetration of the formal Kenya market represented by large millers. Furthermore, Uganda lacks an authoritative price determination point, e.g., a central commodity exchange or futures market, national maize quality standards, and a legal and regulatory framework covering grain warehousing and handling operations. These deficiencies, together with inadequate finance to enable the development of an efficient warehouse receipt financing system, constrain the holding of stocks, essential for the exploitation of export marketing opportunities in particular (MAFAP, 2012)

2.6: Maize quality parameters

Quality refers to the characteristics of food that are acceptable to consumers. This includes external factor such as appearance (size, shape, color, gloss, and consistency), texture and flavor; factors such as grade standards and internal (chemical, physical and microbial) (www.bolibio.com/definition-of -food-quality) World Food Program presents a chart that describes maize grain quality specifications with regards to moisture content, color, pest damage, rotten and diseased grains, shriveled grains, defective grains, filth, inorganic and foreign matter, other grain, live and dead insects and total flatoxins. (WFP, 2013)

Table 1: General maize grade standards

No.	Analysis/test	Limits	Reference method or (equivalent)
1	Organoleptic	Natural state, smell and color	Organoleptic examination
2	Moisture	13.5%w/w max	ISO 712-2009
3	Other colour maize	5.0%w/w max	Visual examination
4	Pest damage grains	3.0%w/w max	Visual examination
5	Rotten and diseased grains	4.0%w/w max	Visual examination
6	Discolored grains	1.0%w/w max	Visual examination
7	Immature/shriveled grains	2.0%w/w max	Visual examination
8	Total defective grains	5.0%w/w max	Visual examination
9	Filth	0.1% w/w max	Visual examination
10	Inorganic matter	0.5% w/w max	Visual examination
11	Foreign matter	1.0% w/w max	Visual examination
12	Other grains	2.0%w/w max	Visual examination
13	Live insect	Nil	(ISO 6639-1,2,3 & 4)
14	Dead insects	Max 10 dead insects per k.g	Visual examination
15	Broken grains	4.0%w/w max	ISO 5223-1995
16	Total aflatoxins	20ppb max	AOAC972.26; AAC45-16; ISO 1650
17	GMO (only if required)	Negative (<0.9% of GMO material as per EU regulation 1830/2003)	

Source: (WFP, 2013)

Table 2 below summarizes the East African specific grade standards for maize grain in terms of foreign matter, inorganic matter, broken kernels, pest damaged grains, rotten and diseased grains, discolored grains, moisture, shriveled grains, filth, defective grains and total flatoxins. The table also summarizes the different grades of maize according to the maximum limits of the specific requirements.

Table 2: Specific East African requirements

S/N	Characteristics	Maximum	Limits		Method of test
		Grade 1	Grade 2	Grade 3	
i)	Foreign matter, % m/m	0.5	1.0	1.5	ISO 605
ii)	Inorganic matter, % m/m	0.25	0.5	0.75	
iii)	Broken kernels, % m/m	2.0	4.0	6.0	
iv)	Pest damaged grains, %m/m	1.0	3.0	5.0	
v)	Rotten & diseased grains, m/m	2.0	4.0	5.0	
vi)	Discolored grains, %m/m	0.5	1.0	1.5	ISO 711/712
vii)	Moisture, %m/m		13.5		
viii)	Immature/shriveled grains, % m/m	1.0	2.0	3.0	ISO 605
ix)	Filth, % m/m		0.1		ISO 605
x)	Total defective grains, % m/m	3.2	7.0	8.5	ISO 605
xi)	Total aflatoxin (AFB ₁ +AFB ₂ +AFG ₁ +AFG ₂) ppb		10		ISO 16050
xii)	Aflatoxin B ₁ , ppb		5		AOAC 2001.04
xiii)	Fumonisin, ppm		2		

Source: (EAS, 2013)

Note, the parameter, total defective grains is not the sum total of the individual defects, it is limited to 70% of the sum total of individual defects.

2.7: Aflatoxins

Aflatoxins produced by *Aspergillus flavus*/*A. parasiticus* are the most common and naturally occurring mycotoxins. Aflatoxins are considered to be among the most carcinogenic substances known and present a very serious health risk to people and animals of all ages (Lawley, 2013). They are extremely difficult to identify by farmers as they have minimal smell, feel or taste and laboratory testing is normally required to discover its presence (IFPRI, 2010). The World Health Organization states that aflatoxins directly contribute to liver cancer, impaired immune function, stunted growth in children and are the third leading cause of cancer deaths globally (WHO, 2008).

The problem of grain contamination, and the resulting poisoning, has become so widespread throughout Africa, particularly in the East African region, that it is now considered an epidemic (USAID & DANYA, 2013). Particularly prominent in maize (the largest crop produced in SSA), aflatoxin contamination occurs when crops come into contact with soil or debris during harvesting, threshing, and drying. Contamination of crops can also occur after grain has been placed into storage, due to pest infestation and poor storage conditions that lead to accelerated growth rates of the fungi. Aflatoxin is a highly potent liver toxin and has been declared by the USA Food and Drug Administration (FDA) to be at a defect action level for grain products when above 20 parts per billion (ppb). Although analytical chemists are capable of conducting laboratory tests measuring 1ppb (which is the equivalent of measuring one second every 32 years (Yoe, 2015), for the purpose of project field testing, the FDA level of 20 ppb was the accepted benchmark.

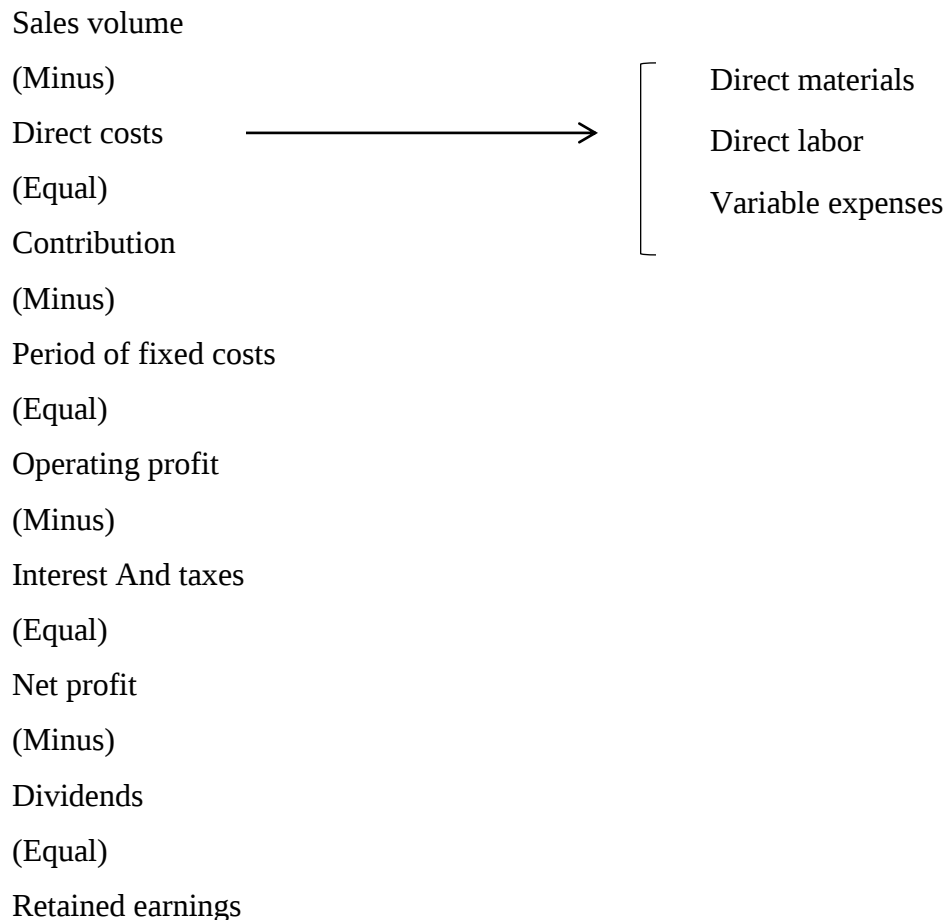
Research by (Kaaya, 2011) reveals that aflatoxin contamination in maize in Uganda is at a maximum level of 701ppb.

2.8: Profitability

The word profitability is composed of two words, namely; profit and ability. The term ability indicates the power of a firm to earn profits. The ability of an enterprise also denotes its earning power or operating performance. Also, that the business ability points towards the financial and operational ability of the business. So, on this basis profitability may be

defined as the ability of a given instrument to earn a return from its use.(Bion & Miller 2011)

Profit performance chart



Source: Adapted from (Richard, 2012)

2.8.1: Variable costs

A variable cost is a cost that varies in relation to changes in the volume of activity. The variable cost concept can be used to model the future financial performance of a business; as well as to set minimum price points. (www.accountingtools.com/dictionary_variable_cost)

2.8.2: Fixed costs

Fixed costs are costs that are independent of output. These remain constant throughout the relevant range and are usually considered sunk for the relevant range (not relevant to output decisions). (www.fundermentalfinance.com/micro_costs.php)

CHAPTER THREE

3.0: RESEARCH DESIGN AND METHODOLOGY

3.1: Introduction

This section is intended to provide the scope of the study, the data collection methods to be used in the study, the research design, sampling framework and research procedure.

3.2: Scope of the study

3.2.1: Subject scope

The study was conducted on the causes of post-harvest losses in maize and their effects on the profitability of agribusiness enterprises.

3.2.2: Geographical scope

The study was conducted in Masindi district, Masindi municipality during the period December 2015 to August 2016. Masindi District is located in the Western Region of Uganda. Its headquarters are in Masindi town located approximately 217km from Kampala. It is bordered by Nakasongola, Kiboga, Nakaseke, Hoima, Buliisa and Kiryandongo. The district has a municipal and two counties (Bujenje and Buruli), (CIS, 2011).

Masindi Municipality is located North West of Kampala at a latitude of $01^{\circ} 41^{\circ}$ North of the Equator at a longitude of $30^{\circ} 43^{\circ}$ East of Greenwich Meridian and at an altitude of 1147 meters above sea level. It is 211Kms, North West of Kampala. It borders four sub counties, Miirya, Kimengo, Pakanyi and Budongo. Masindi Municipal Council is located at the Centre of Economic opportunities in the District. The Municipal Council has a rich hinterland with a lot of potential wealth. It is at the Centre of roads going to Murchison Falls National Park, Budongo Forest, Bugungu and Karuma Game reserves; and Kinyara Sugar Cane Plantations which are about 10Kms from Masindi Town. Besides, Masindi Town is a Centre for roads connecting to the massive water bodies of Lakes Albert and Kyoga and River Nile as well. Masindi Municipality has an estimated area of 420 sq. km. The Municipal Council is divided into four Divisions namely Central, Kigulya, Nyangahya and Karujubu. The Municipal council has eleven

(11) wards and eighty three (83) village councils. (MASINDI MUNICIPALITY, 2012) The study covered 8 wards including two from each division.

3.3: Research design

The research design that was used was case study. This particular design was used to examine in detail the different causes of post-harvest losses and their effects on the profitability of agribusiness enterprises in municipality.

Both qualitative and quantitative approaches of research were used. Qualitative approach was used to generally generate information on perceptions and attitude of maize farmers and other stakeholders on the maize platform in relation to post-harvest losses and profitability of the maize enterprise. Quantitative methods were used to measure the statistical extent or trend of post-harvest handling in relation to the profitability of the maize enterprise.

3.4: Study population

The study population was comprised of maize farmers, maize buyers, maize processors and any other stake holders on the maize platform. This target group constituted of people with experience and knowledge of maize handling at different levels. This target group was also having knowledge on post-harvest losses at their respective levels.

A relevant and purposeful deliberate assessment was made on Masindi town council, civic center central cell I, since it's the major business center and base for the headquarters of different agricultural organizations such as Masindi District Farmers Association (MADFA), Masindi Seed And Grain Growers Limited, Joseph Initiative, and Operation Wealth Creation (OWC) for Masindi district.

3.5: Sampling procedures

In this frame work, both purposive and simple random sampling as techniques for easy collection of required and reliable data was used. The target population was selected purposively including the technocrats involved in maize handling at different levels. Ten questionnaires were allocated to each ward of the study sample to make a total of 80 questionnaires.

3.6: Data sources

Data was collected from both primary and secondary sources.

3.7: Research instruments

The following instruments of data collection were used.

3.7.1: The questionnaire

A total of 80 questionnaires were purposively and randomly administered to the respondents in the selected wards. 50 maize farmers and 30 maize traders were considered. Questions were asked and recorded in English. For the respondents who cannot read and write, questions were interpreted in the local languages (Runyoro, Rugungu and Kiswahili).

This was involving the use of set ready questions to be answered by the respondents by writing down the answers, all set questions were reflecting on the research topic. Closed ended questions were considered most and directed to the section of target group of respondents. This was containing different research questions and was filled by only respondents who could read and write.

3.7.2: Interviews

Interviews involved asking oral questions to respondents. This was done with the different maize farmers, maize store owners, maize processors and any other stakeholder on the maize platform.

3.8: Validity and reliability of data

Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. Reliability refers to the extent to which results are consistent over time and an accurate representation of the total population under the study, (Joppe, 2000).

Validity and reliability was ensured by pretesting all the instruments to ignore vague, repetitions, misleading and ambiguous questions. Continuous consultation with the supervisor were done to

ensure adjustments are made to the data collection instruments in order to keep in line with the study in question and the main problem under investigation.

The pretest of data was done in one ward and one village from the sample study district to inform the researcher on the questionnaire challenges and reliability in terms of realizing all the problem investigative objectives. It was also to inform alterations such as question rephrasing, alignment and missing gap in the tool. The pretest findings were shared with the supervisor in a consultative manner and the responses from this consultation created and provided a baseline situation to the main study in the entire municipality.

3.9: Data analysis

Questionnaire survey data was entered in Microsoft Excel. It was checked and edited for errors and coded. Thereafter it was entered in SPSS version 16 where it was analyzed, summarized and reported in figures and tables.

Objective one was analyzed by use of descriptive data where frequencies and percentages were used. A T-test was used to establish the impact of the extent of the post-harvest losses in maize on maize business. Two samples were considered for analysis, data about the post-harvest losses during the process of transportation, storage, drying, and shelling was considered to be for the before sell period.(1st sample). Data about storage by traders was considered to be for the after sale period. (2nd sample)

H₀: the extent of post-harvest losses in maize has a significant impact on maize business.

H₁: the extent of pot-harvest losses in maize has no significant effect on maize business.

$T_{\text{calculated}} > T_{\text{tabulated}}$.

Reject the null,

$T_{\text{calculated}} < T_{\text{tabulated}}$,

Accept the null.

$$T_{\text{calculated}} = \frac{d}{sd / \sqrt{n}}$$

Where, d= difference between pairs of data

d= mean of these difference

sd = standard deviation of the pairs of data

n = number of observations
 $t(0.05, n-1)$

A gross margin analysis was used to analyze the profitability of maize business. This was done as follows;

$$GM = TR - TVC$$

Where: GM....Gross margin.

TR.....Total revenue

TVC...Total Variable Costs.

Linear regression analysis was used to analyze objective three that is the effects of the different causes of post-harvest losses on the profitability of agribusiness enterprises in Masindi Municipality.

3.10: Ethical considerations

The university wrote an introductory letter permitting the researcher to carry out the study and collect data in the respective places. Permission was also got from the government and other relevant authorities at the district.

3.11: Limitations

The following were the limitations faced during the course of data collection and the entire study.

The district agricultural department hid back some data that was vital and critical to the study

The farmers in Masindi district and other maize dealers were not willing to reveal some information that was required for the study to be a success.

Money was not forthcoming to meet the financial requirements during data collection for example transport. With other academic load on hand, presenting the report in time was in vein.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Introduction.

Chapter four shows the research findings and the discussions in form of tables, graphs, percentages and statistical data as frequencies and mean. It covers the area of social and demographic characteristics of the maize farmers and maize traders, identification of the main causes of post-harvest losses among the maize farmers and maize traders, the extent of the post-harvest losses and gross margin analysis, showing the effects of post-harvest losses on the profitability of agribusiness enterprises.

4.2 Social - demographic characteristics.

Figure 4 shows the percentage of males and females involved in maize production and trade. Results show that males dominated maize production and trade at (76.2%) while only 23.8% were females. FAO, (2011) and Nkonga et al (2004), in the study of women participation in farm activities found that women were more efficient and provide most of the farm labor which is contrary to the findings of the study. A report by (USAID, 2010) reveals that female business owners face a difficult market, with several barriers to entry, including a complex and lengthy process of registration, poor access to credit, and challenges in access to land tenure and property rights. Women have also reported greater incidences of government interference in their businesses than their male counterparts. This accounts for the less involvement of women in maize business.

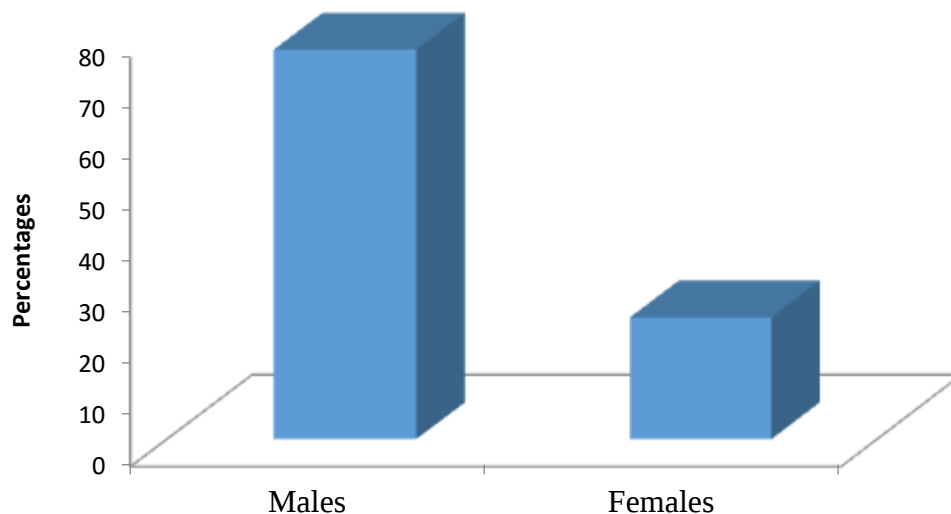


Figure 4: Percentage of male and female respondents producing and trading in maize.

4.3: Level of Education

Of the farmers contacted, majority (26.2%) completed senior four, 21.2% completed primary seven, 15.0% completed senior six, 12.5% did not complete primary, 11.2% had obtained diplomas, 11.2% had obtained degrees at universities and 2.5% had obtained masters. (Table 3). This finding shows that concerned parties such as the government, parents and any other stakeholders should invest more in education to enable Ugandans reach higher learning levels, gain more skills and knowledge to enable them improve their productivity and profitability.

Table 3: Frequency and percentage of farmers according to their level of education

Level of Education	Frequency	Percent	Valid Percent	Cumulative Percent
Masters	2	2.5	2.5	2.5
Degree	9	11.2	11.2	13.8
Diploma	9	11.2	11.2	25.0
HAC	12	15.0	15.0	40.0
UCE	21	26.2	26.2	66.2
P.7	17	21.2	21.2	87.5
Did Not Complete Primary	10	12.5	12.5	100.0
Total	80	100.0	100.0	

4.4: Main occupation

Majority, (43.8%) of the 80 respondents contacted were farmers, 23.8% traders, 7.5% civil servants, 10.0% professional workers, 3.8% students, and 9% were engaged in other activities. Survey by UBOS in 2014 shows that 71.9% of Ugandans are employed in Agriculture, forestry and fishing, 15.8% engaged in wholesale and retail activities. This accounts for the high percentage of the respondents practicing farming and trading as their main occupation.

Table 4: Frequency and percentage of maize farmers and traders according to their main occupation

Occupation	Frequency	Percent	Percent
Farmer	35	43.8	43.8
Trader	19	23.8	23.8
Civil Servant	6	7.5	7.5
Professional Worker	8	10.0	10.0
Student	3	3.8	3.8
Others	9	11.2	11.2
Total	80	100.0	100.

4.5: Type of material where maize is heaped during harvesting.

Figure 5 shows the percentage of farmers who use tarpaulins and those who heap their maize on bare ground during harvesting. Of the 50 maize farmers contacted, (58%) heap their maize on bare ground during harvesting and only 42% use tarpaulins. This leads to contamination of maize immediately after harvest. In addition, a study by FAO, (2010) shows that it is necessary to remove dust and contaminants, which can include insects, and vegetable material, such as bits of straw and chaff and weed seeds. These fill up pore spaces within the crop, inhibiting air movement and adding to any possible spoilage problems. This therefore identifies failure to use tarpaulins during harvesting among most farmers in Masindi municipality as one of the causes of post-harvest losses in maize.

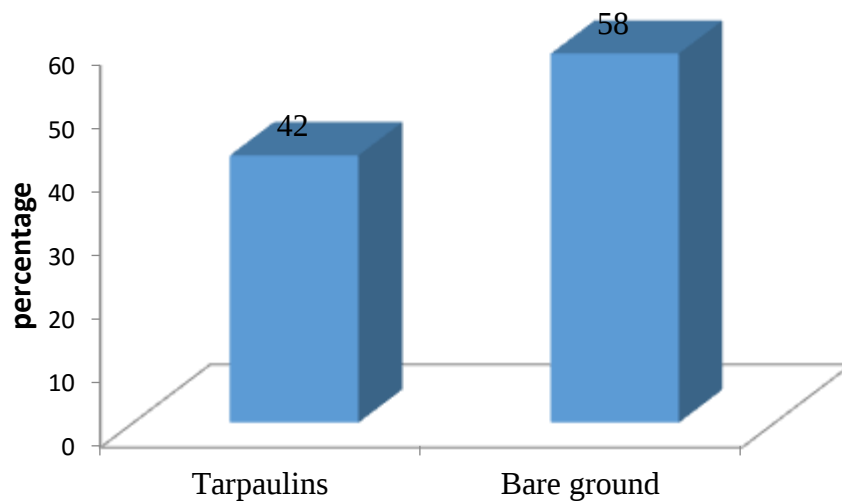


Figure 5: Percentage of farmers using tarpaulins and those who heap the maize on bare ground during harvesting

4.6: Immediate transportation of maize for storage at the day of harvest.

Figure 6 shows the percentage of maize farmers who immediately transport their maize for storage and those who transport it after some days. Of the 50 maize farmers contacted, (58%) immediately transport their maize for storage and 42% transport it after some days. This shows the amount of maize that could be lost to birds, rodents and theft due to delayed transportation.

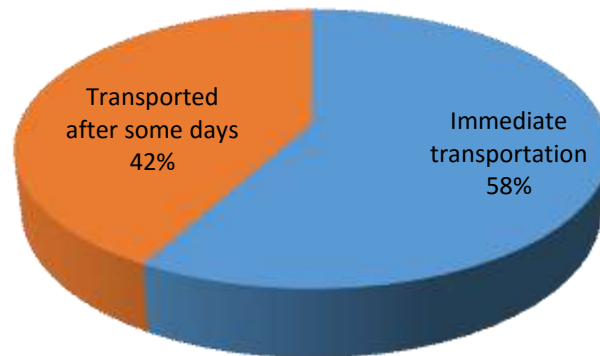


Figure 6: Percentage of farmers who immediately transport their maize for storage and those who transport it after some days.

4.7: Type of storage facility used by farmers.

Of the 50 maize farmers surveyed, majority (52%) had locally constructed cribs, 12% had local granaries, only 10% had modern cribs and 26% had their other own ways of storing maize. As highlighted by Lowenberg and Jones,(2011) in their study on the economics of maize storage show that to be able to achieve the objectives of maize storage, the store must satisfy the following parameters as far as possible: (a) the grain must be kept dry; (b) the grain should be kept at a uniform temperature; (c) the grain should be protected from insect attack; (d) rodents and birds should be excluded. With the majority of farmers having locally constructed maize cribs, these may not fully meet the parameters of proper maize storage therefore identifying the type of storage facilities farmers use as one of the causes of post-harvest loss in maize.

Table 5: Frequency and percentage of maize farmers according to the type of storage facility.

Type of storage facility used.	Frequency	Percent	Percent
Modern maize crib	5	6.2	10.0
Locally constructed crib	26	32.5	52.0
Local granary	6	7.5	12.0
Others	13	16.2	26.0
Total	50	62.5	100.0

4.8: Main causes of post-harvest losses during storage among maize farmers and maize traders.

According to the respondents, insects were the main cause of post-harvest losses during storage (40%) of the farmers contacted and 50% of the traders contacted. They were followed by rodents at 26% and 30% among farmers and traders respectively. Molding was at 26% and 16.7% among farmers and traders respectively. Farmers and traders also reported that they are normally

disturbed by thieves (4%) and 3.3% respectively. Other factors accounted for 4% loss among the farmers contacted.

Table 6: Frequency and percentage of farmers and traders according to the main cause of post-harvest loss during storage

FARMERS		
Main cause of post-harvest loss	Frequency	Percent
Insects	20	40.0
Rodents	13	26.0
Thieves	2	4.0
Molding	13	26.0
Others	2	4.0
Total	50	100.0

TRADERS		
Main Cause Of Post-Harvest Loss	Frequency	Percent
Insects	25	50
Rodents	2	30
Molding	3	16.7
Thieves	1	3.3
Total	30	100.0

4.9: Maize drying

From the 50 farmers contacted, majority (36%) leave their maize to dry inside the cribs, 34% use sun heat by spreading the maize on the tarpaulins, 24% use sun heat by spreading the maize on bare ground and 6% use other ways to dry their maize. From the analysis in 4.6 above, that shows that most farmers use locally constructed cribs to store their maize. These do not meet 100% parameters for proper maize storage. Most farmers leaving their maize to dry in the cribs imply that this maize will highly be exposed to post-harvest losses. The 24% of the farmers who dry their maize on bare ground face risks of maize contamination that increases post-harvest losses as explained in the FAO, (2010) report that shows the relevancy of excluding dust and any other contaminant from maize.

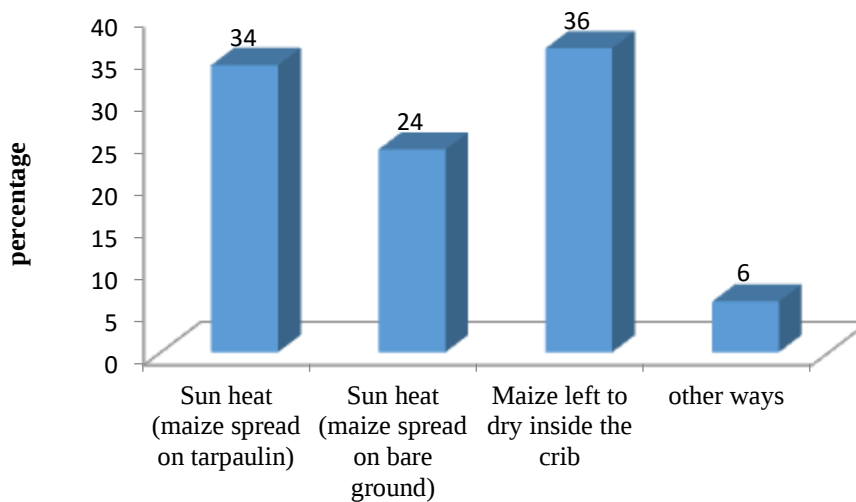


Figure 7: Percentage of maize farmers using drying method.

4.10: Maize shelling.

Of the farmers contacted, majority (76%) use maize shellers, 18% shell by beating with sticks and 6% use hands to shell their maize. As revealed in the international journal for innovative research in science and technology in 2015, using maize shellers was found to be more efficient, labor and time saving. It was also found that using maize shellers reduces the percentage of broken grains and also helps in ensuring production of clean grain. (IJIRST, 2015).

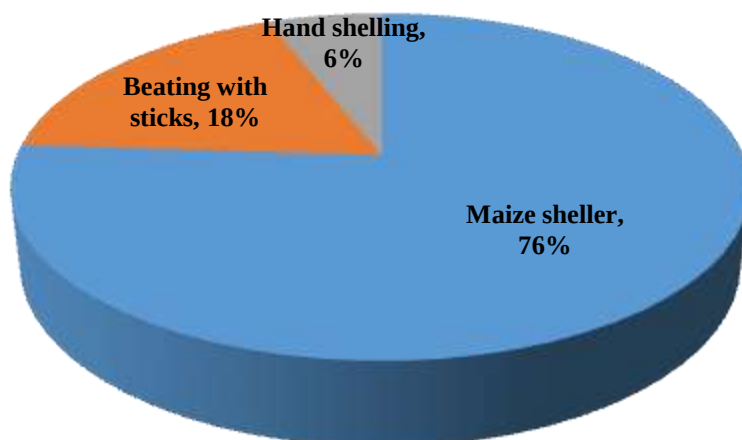


Figure 8: Percentage of maize farmers according to shelling method.

4.10.1: Method used to ensure cleanliness and reduced scattering of maize during shelling

Majority (70%) out of the farmers contacted use tarpaulins to ensure cleanliness and reduced scattering of maize during shelling, 24% use other materials and 6% shell on bare ground. As revealed in a study by FAO, (2010) it is necessary to remove dust and contaminants from maize. These fill up pore spaces within the crop, inhibiting air movement and adding to any possible spoilage problems. The ability of most farmers to use tarpaulins implies that they are able to keep their maize clean as well as reducing the rate of scattering.

Table 7: Frequency and percentage of maize farmers using tarpaulins to ensure cleanliness and reduced scattering of maize during shelling

Method used	Frequency	Percent
Tarpaulin	35	70.0
Bare Ground	3	6.0
Others	12	24.0
Total	50	100.0

4.11: Maize packaging

Of the farmers surveyed, majority (96%) use polypropylene bags for packaging their maize, 2% use super grain bags and 2% use other materials. All the traders who were contacted use polypropylene bags. The study found that super grain bags were under less usage. The use of super grain bags help in keeping the original moisture content and reducing pest damage without using pesticides. (IRRI, 2014). Other forms of hermetic storage were also found not to be under usage by farmers. Hermetic storage is a method used to control insect infestation and preserve the quality of grain (Quezada et al., 2006). The use polypropylene bags by most farmers and traders imply that their maize faces high risks of deterioration if not kept well.

Table 8: Frequency and percentage of farmers and traders according to the type of packaging material used

Material used by farmers	Frequency	Percent
Polypropylene bags	48	96.0
Super grain bag (multi-layer polyethylene storage bag)	1	2.0
Others	1	2.0
Total	50	100.0

Material used by traders	Frequency	Percent
polypropylene bag	30	100.0
Super grain bag (multi-layer polyethylene storage bag)	0	0
Others	0	0
Total	30	100.0

4.12: Fumigation

Of the maize traders contacted, (53.3%) do fumigate their stores whereas 46.7% do not fumigate their stores. Fumigation helps to kill grain pests at all stages of their life cycle. Failure to fumigate increases chances of pest survival with in maize that lead to post-harvest losses which reduce the profitability of maize business. ECOSAFE, (2016) in a study on fumigation show that fumigants are of great importance in grain storage since they are toxic to a wide range of pests, can penetrate cracks, crevices, wood, and tightly packed areas of stored grains, a single treatment usually kills most pests in treated areas.

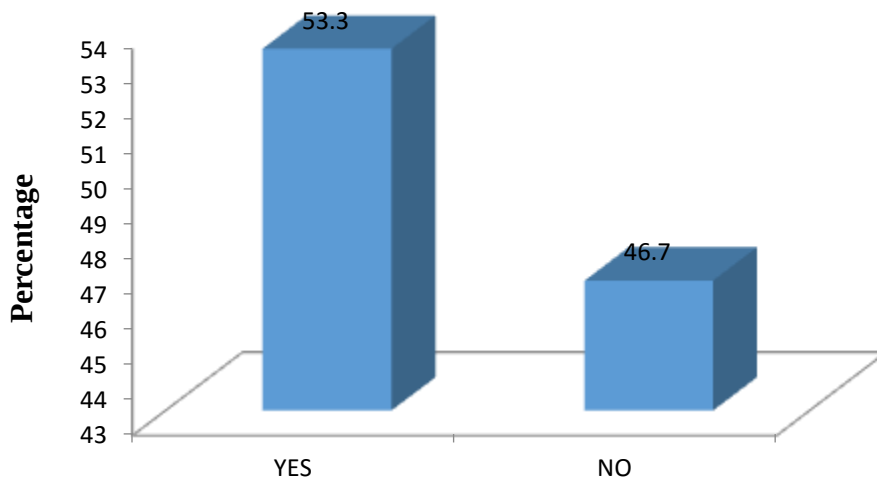


Figure 9: Percentage of maize traders who fumigate their stores

4.13: Humidity and Ground moisture uptake by maize.

Majority of the maize traders (76.7%) use pallets to control ground moisture uptake by maize where as 20.0% and 3.3% use logs and other materials respectively. There is movement of water vapor between stored food and its surrounding atmosphere until equilibrium of water activity in the food and the atmosphere. A moist food will give up moisture to the air while a dry food will absorb moisture from the air. Dried or dehydrated products like maize need to be stored under conditions of low relative humidity in order to avoid absorbing moisture to the point where mold growth occurs (Atanda et al. 2011). This shows the importance of the use of pallets during storage.

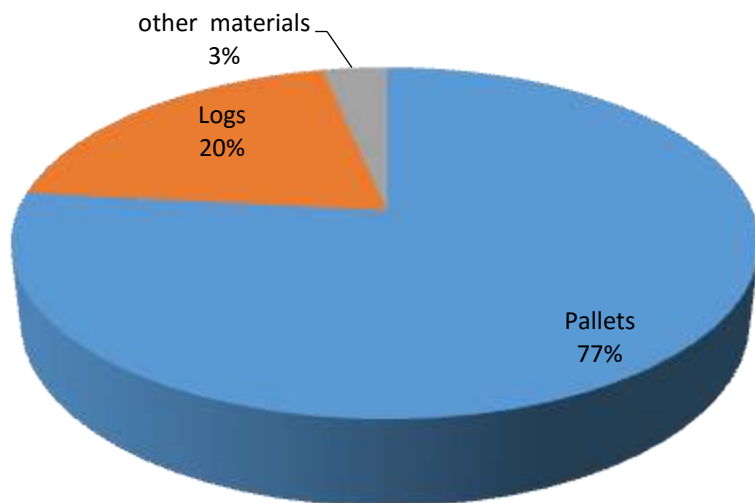


Figure 10: Percentage of maize traders using moisture control methods.

4.14: Awareness of maize grade standards by farmers and traders.

Majority of the farmers contacted (67.3%) were not aware of the maize grain quality standards. Only 32.7% were aware of grain quality standards. Of the traders contacted, only 46.7% were aware the maize grain standards whereas the majority (53.3%) were not aware of the maize grain standards. In a policy note by John Keyser written in July 2012, he reveals that the consequences of different standards can be “devastating” for small traders who are likely to be unaware of the differences in each country’s requirements and may only learn about the required standards at the border. To support this claim, RATES, (2003) gives the example of Ugandan maize with 14% moisture being rejected at the Kenyan border where inspectors insisted on a maximum of 13.5% moisture. While maize with 14% moisture would not have met Uganda’s own import requirements of 13% maximum moisture, this difference led to supplies being held up from formal crossings and having to go across in small informal loads by bicycle and other circuitous means. With the majority of maize farmers and traders contacted not being aware of the maize grain standards implies that they face risks of producing low quality maize that cannot yield much profits in their maize business.

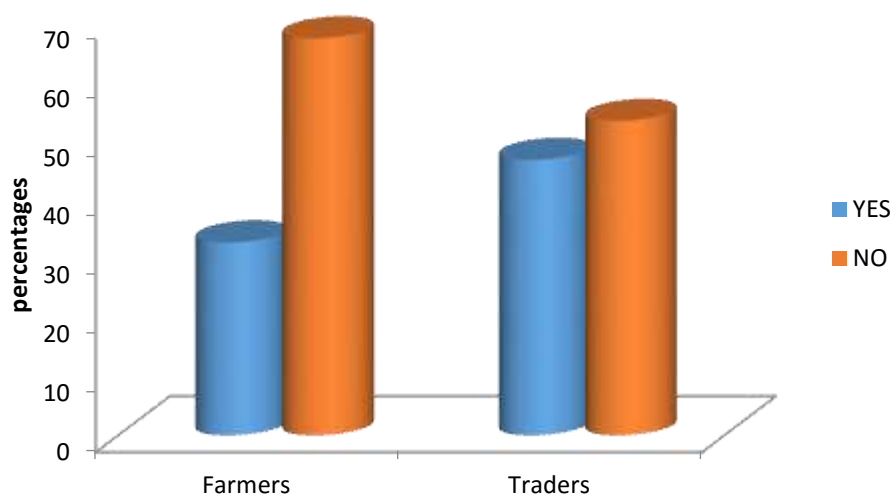


Figure 11: Percentage of maize farmers and traders who are aware of the maize standards.

4.15.1: The extent of post-harvest losses on maize business

The majority of the respondents (44.6%) experience a percentage loss of maize of 5%-9% during transportation. A big number of 36% and 36% experience a percentage loss of 5%-9% and 10%-29% respectively during storage before shelling. During drying majority of the farmers 38% experience a percentage loss of 5%-9%. A good number of farmers that is 46% and 42% experience percentage losses of 1%-4% and 5%-9% respectively. During storage after shelling majority of the farmers 46.7% experience percentage loss of 5%-9%.

The percentage losses incurred by majority of the farmers at all the selected stages of production are far above the percentage losses estimated by APHLIS (2013). The APHLIS loss manual estimated post-harvest losses in cereals including maize as follows, harvesting 4%-8%, transportation to homestead 2%-4%, drying 1%-2%, threshing/shelling 1%-3%, winnowing 1%-3%, farm storage 2%-5%, transport to market 1%-2% and market storage 2%-4% totaling to a cumulative loss from production of 10%-23%.

Table 9: Percentage of farmers estimating maize lost at different stages of the value chain

% of maize lost	Transportation	Storage before shelling	Drying stage	Shelling stage	Storage after shelling
50% and above	0.0	4.0	0.0	0.0	0.0
30%-49%	4.3	12.0	2.0	0.0	10.0
10%-29%	10.6	36.0	36.0	12.0	16.7
5%-9%	44.6	36.0	38.0	42.0	46.7
1%-4%	40.5	12.0	24.0	46.0	26.6
TOTAL	100.0	100.0	100.0	100.0	100.0

4.15.2: Impact of the extent of post-harvest losses on maize business.

Table 10 summarizes the percentage loss estimates at different stages of the value chain before harvest and after harvest showing the difference and average standard deviation.

Table 10: Average standard deviation and difference between percentage loss estimates in the value chain before and after sale

OBSERVATION	EXTENT	BEFORE		DIFFERENCE
		SALE	AFTER SALE	
1	50 %and above	2	0	2
2	30%-49%	18	6	12
3	10%-29%	150	15	135
4	5%-9%	312	56	256
5	1%-4%	300	40	260
AVERAGE		156.4	23.4	133
STANDARD DEVIATION				125.5627333

Table 11 summarizes the t-test results showing the impact of the extent of post-harvest losses on maize business.

Table 11: t-test results

t-Test: Paired Two Sample for Means		
	BEFORE SALE	AFTER SALE
Mean	156.4	23.4
Variance	21966.8	564.8
Observations	5	5
Pearson Correlation	0.960385468	
Hypothesized Mean Difference	0	
Df	4	
t Stat	2.368513596	
P(T<=t) one-tail	0.038472717	
t Critical one-tail	2.131846786	
P(T<=t) two-tail	0.076945433	
t Critical two-tail	2.776445105	

$$T_{\text{calculated}} = 2.368513596$$

$$T_{\text{tabulated}} = 0.076945433$$

Sine $T_{\text{calculated}} > T_{\text{tabulated}}$, we reject the null hypothesis implying that the extent of post-harvest losses in maize have a significant impact on maize business.

4.16: Gross margin analysis of maize business.

On average, every maize trader had a gross margin of Ug.shs. 8,297,837.5 This was after investing a total amount of Ug.shs. 66,069,695.7. Every trader on average lost a total quantity of maize of 10,093.7kgs equaling to a total loss Ug.shs. 8,269,768.4. Leaving other factors constant and only considering the total maize lost due to post-harvest handling, it shows how much post-harvest losses reduce the profitability of maize business. Every maize trader on average lost money almost equivalent to his gross margin profits earned.

Table 12: Maize traders' average gross margin

Particular	N	Mean (shs)
Fuel	30	256,333.3
Transport	30	6,908,333
Labor	30	684,080
Packaging materials	30	807,873.3
Truck maintenance	30	285,666.6
Fumigation	30	188,333.3
Rent	30	260,000
Re-bagging	30	1,333.3
Other costs	30	43,000
Per unit maize buying price	30	561.5
Cost of buying maize	30	56,634,742.9
Average quantity bulked up	30	100,863.3kgs
Average quantity of maize sold off	30	90,769.6kgs
Average quantity of maize lost	30	10,093.7kgs
Average amount of money lost	30	8,269,768.4
TVC		66,069,695.7
Average selling price		819.3
Average total revenue		74,367,533.2
Average gross margin		8,297,837.5

4.17: The effect of the causes of post-harvest losses in maize on the profitability of agribusiness enterprises.

Table 13 summarizes the linear regression analysis results showing the relationship between the farmers' average gross margin and the different causes of post-harvest losses.

Table 13: The relationship between farmers' gross margin and the different causes of post-harvest losses

Model	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	5.023E6	6.101E6		.823	.418
Level of education	636886.004	477694.853	.273	1.333	.194
Main Occupation	29189.049	404696.305	.013	.072	.943
Mode used to transport harvest for storage	61707.697	681534.948	.017	.091	.929
Average quantity reduction in the maize loaded for transportation and that offloaded for storage	-1.625E6	706553.546	-.337	-2.299	.030
Type of storage facility used to store harvested maize	-2.069E6	751629.628	-.541	-2.752	.011
Three causes of post-harvest loss in the storage facility	4.408E6	1.847E6	-.338	2.386	.025
One major cause of post-harvest loss from the above	401796.136	535485.149	.144	.750	.460
% qualitative and quantitative loss caused by the major cause of post-harvest loss identified above	944818.929	696459.256	.237	1.357	.187
% of maize lost during drying	-1.779E6	904570.824	-.362	-1.966	.060
Method used in shelling maize	-2.030E6	1.013E6	-.316	-2.003	.056
Period for which maize is stored before being sold off	-583326.173	600338.465	-.145	-.972	.340
Adjusted R square	0.342				
F	2.422				0.023

Dependent variable: Farmers gross margin (in Uganda shillings)

Independent variables: The different possible causes of post-harvest losses.

The mode of transport used by farmers to transport their maize from the garden to their stores has a significant effect on the gross margins received by farmers. A unit reduction in the maize that is loaded for transportation from the garden and that offloaded for storage reduces the gross margin. This has a coefficient of -0.337 and is significant at 0.030. The kind of storage facilities used by farmers to store their harvested maize have a significant effect on the gross margins received. These have a coefficient of -0.541 and are significant at 0.011, implying that they reduce the farmers' gross margins. The three causes of post-harvest loss in the storage facility (insects, rodents and molding) also have a significant effect on the farmers' gross margins. These have a coefficient of -0.338 and are significant at 0.025. This implies that a unit increase in the amount of loss caused by these three causes of post-harvest loss in the storage facility reduces the farmers' gross margin.

The percentage of maize lost during drying has a negative effect on the profitability of maize business. A one unit reduction in maize during drying reduces the gross margin by -0.362 and is significant at 10%. The method used in shelling maize also has a negative impact on the profits since it reduces the gross margin by -0.316 and is significant at 10%.

Other variables that were considered include; level of education, main occupation, and the period for which maize is stored before selling it off. Adjusted R square of .0342 means that the independent variables affect 34.2 percent of the variables observed in the dependent variable. F of 2.422 with significance of 0.023, shows that the independent variables affect the dependent variable significantly at 95% confidence and therefore the model is significant.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS.

5.1: Conclusions.

The main causes of post-harvest losses among the farmers were; heaping of maize on bare ground during harvesting, this increase chances of chaff and soil accumulation in maize which lower the quality of the final maize product. The study found out that a good number of farmers do not transport their maize from the garden to the storage facilities; maize is first left in the garden which increases risks of pest attack and theft lowering the quantity that is to be transported home. Majority (52%) of the farmers had locally constructed maize cribs, these were not efficient enough since they lacked the basic qualities of a good maize storage facility such as a good leak proof, good aeration and ability to control moisture. The main causes of post-harvest losses in the farmers' storage facilities were found to be insects, rodents and molding with majority of the farmers (40%), 26% and 26% being affected by insects, rodents and molding respectively. Most farmers (96%) use polypropylene bags for packaging their maize, these are not so efficient in proper maize storage like the super grain bags. Majority of the farmers (67.3%) were not aware of the maize grain quality standards, this implies that they face risks of producing low quality maize that does not meet the required standards lowering their expected profits.

The main causes of post-harvest losses among the traders were, insects, rodents and molding with insects being the main factor among the majority of the traders (50%). None of the traders contacted practiced hermetic storage, they all use polypropylene bags for packaging their maize. These are not so perfect in maize storage compared to super grain bags and other forms of hermetic storage. High rate of unawareness of maize grain quality standards among the traders with majority (53.4%) of the maize traders being unaware of the maize grain quality standards. this implies that these traders face risks of their maize being rejected on markets that have specified maize grain quality standards which their maize may not meet.

Pallets were found to be under good usage among majority of the maize traders (77%), this shows that most maize traders are able to control ground moisture uptake by maize. Most maize

traders (53.3%) fumigate their storage facilities though the study revealed that they were highly disturbed by insects. This implies that the fumigants they use are questionable or they could be facing challenges of proper usage of those fumigants.

On average, every maize trader had a gross margin of Uganda shillings 8,297,837.5, this was after investing an average total amount of Uganda shillings 66,069,695.7. This shows that maize business is profitable but there is need to reduce the post-harvest losses so that the profits can be increased.

5.2: Recommendations.

To reduce post-harvest losses of maize, farmers and trader should adopt the use of tarpaulin at the different stages of maize production for example during harvesting, drying and shelling. This can help in production of clean maize and also reduce maize quantity reduction through scattering. This will help reduce losses that arise due to dirty maize that is rejected by the buyers and also reduce the direct quantity reductions that arise from maize scattering

Farmers should always ensure immediate transportation of the harvested maize to their storage facilities on the day of harvest. This will help reduce losses that arise from the reduction in the quantity harvested due to pests like birds, rodents and theft. Immediate transportation also helps reduce quality deterioration due rain and other environmental factors.

The concerned authorities like Government should help farmers in improving their storage facilities. This can be done by availing farmers with credit facilities to enable them construct modern cribs that can facilitate better storage of maize compared to the locally constructed cribs that majority of the farmers are using.

The government should also invest more in education and training to equip the farmers with skills and knowledge in agriculture so that they can be able to apply them in the field to improve on their competences since the level of education is expected to have a positive relationship with the gross margin per hectare but its insignificant in this particular study. More emphasis should also be put on post-harvest handling to ensure that losses that arise due to poor post-harvest handling of maize are reduced.

There is need to improve on the packaging materials that are used for maize packaging. Concerned stake-holders should subsidize better packaging materials such as super grain bags that provide better conditions of storage compared to polypropylene bags which most farmers and traders are currently using.

Uganda National Bureau of Standards and other concerned regulatory authorities should formulate and implement strict regulations on agro-inputs to ensure that fumigants on market are genuine. Thereafter farmers and traders can be encouraged to always carry out fumigation to reduce pest attack in their maize storage facilities. Emphasis should also be put on ensuring that proper prescriptions are packaged along with the different agro-input chemicals to ensure that fumigants are correctly used.

Setting price floors by the concerned authorities can be done to enable farmers realize better prices for their products. The continuous maize price fluctuations will be reduced through the price floor enabling agribusiness enterprise improve their profitability.

The concerned authorities such as the Government should avail farmers and traders with maize grain quality standards. This can be done by printing and publishing manuals in different languages that can easily be understood and interpreted by the farmers and traders. Mass education should also be done on all local radio stations to help farmers and traders be fully availed with maize quality standards at different market levels.

5.3: Areas for further research.

There is need to carry out more research on the effects of the various governing policies on the productivity and profitability of agribusiness enterprises. More research is also needed on the pre-harvest factors that lead to increased risk of post-harvest losses in maize. There is also need to carry out more research on the effects of the different agricultural practices on the productivity and profitability of maize business. The causes of maize price fluctuations are also another area for further research.

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APPENDICES

Questionnaire

Dear sir/Madame,

My name is **Ategeka Stewart**, a third year student of Makerere University pursuing a bachelor of Agribusiness Management. I am carrying out a study to assess the causes of post-harvest losses in maize and their effects on the profitability of agribusiness enterprises in Masindi municipality. This is to give an insight on the extent of post-harvest losses in maize in the municipality. The study is anticipated to contribute to the existing data and will help guide decision and policy makers in the future on the aspects concerning maize production and the need to need to control post-harvest losses.

Therefore, I humbly request you to respond to the questions in this questionnaire to enable me get the required information. All the information you provide me will be used only for purposes of this research and therefore considered confidential.

Section A: Background information (Bio-Data).

Name

Ward

Division

Cell

Please **TICK** the response most appropriate to you

Code	Question (s)	Alternative	tick
01	Gender	(a) Male	
		(b) Female	
02	Age range	(a) Below 19	
		(b) 20 – 29	
		(c) 30 – 39	
		(d) 40 – 49	

		(e) 50 – 59	
		(f) 60 and above	
03	Level of education	(a) P hD	
		(b) masters	
		(c) Degree	
		(d) Diploma	
		(e) HAC	
		(f) UCE	
		(g) P.7	
		(h) Did not complete primary	(specify class)
		(i) Never got formal education	
Code	Question(s)	Alternative	Tick
04	Marital status	(a) single	
		(b) married	
		(c) Divorced/separated	
		(d) Widowed	
05	Religion	(a) Anglican	
		(b) Catholic	
		(c) Moslem	
		(d)Others	
06	Main occupation	(a) Farmer	
		(b) Trader	
		(c) Civil servant	
		(d) professional worker	
		(e) house wife	

		(f) Student	
		(g) Others (specify)	
07	What other activity do you engage yourself apart from the one you have mentioned above?		
08	Which language do you understand most?	(a) Runyakitara	
		(b) Luo	
		(c) Kiswahili	
		(d) English	
		(e) Others (specify)	
9	What is your favorite radio station	(a) B.B.S FM	
		(b) Kitara FM	
		(c) K.B.S FM	
		(d) U.B.C west	
		(e) Others (specify)	

Section (B): Questionnaire for farmers

Maize production practices

code	Question	Alternative	Tick
10	How long have you been growing maize?	(a) the whole of my life	
		(b) over 10 years	

		(C) 1-10 years	
		(d) less than a year	
11	What is your average acreage of maize per season?	(a) over 10 hectares	
		(b) 5-10 hectares	
		(c) 1-4 hectares	
		(d) less than a hectare (specify)	
12	What variety of maize do you mainly grow?	(a) local unidentified breeds	
		(b) local	
		(c) MADFA UH5053	
		(d) others (specify)	
13	At what stage do you harvest your maize?		
14	On what materials do you heap your maize during harvesting	(a) tarpaulins	
		(b) other materials (specify)	
		(d) Bare ground	
15	Do you immediately transport your maize for storage on that day of harvest?	(a) yes	
		(b) no	

		(c) after some days (specify)	
		(d) shelled and sold off in garden	
		(e) shelled in garden and transported home	
16	What mode do you use to transport your harvest for storage?	(a) tractor	
		(b) bicycle	
		(c) other (specify)	
17	Do you realize a quantity reduction in the maize loaded for transportation and that offloaded for storage?	(a) yes Specify	
		(i) around 50%	
		(ii) 30%-49%	
		(iii) 10%-29%	
		(iv) 5%-9%	
		(v) 1%-4%	
		(vi) No (0%)	
18	What kind of storage facility do you use to store your harvested maize?	(a) modern maize crib	
		(b) locally constructed crib	
		(c) local granary	
		(d) others (sspecify)	

19	What are the causes of post-harvest loss in your storage facility	Tick multiple options	
		(a) insects	
		(b) rodents	
		(c) thieves	
		(d) moulding	
		(e) others (specify)	
20	Identify one major cause of post-harvest loss from the above and rate the qualitative and quantitative loss of maize in storage before shelling.	(Cause).....	
		(a) beyond 50%	
		(b) 30%-49%	
		(c) 10%-29%	
		(d) 5%-9%	
		(e) 1%-4%	
21	How do you dry your maize	(a) sun heat (maize spread on tarpaulin)	
		(b) sun heat (maize spread on bare ground)	
		(c) sun heat (maize spread on roof top)	
		(d) others (specify)	
22	How can you rate the percentage of maize grain lost during drying?	(a) beyond 50%	
		(b) 30%-49%	

		(c) 10%-29%	
		(d) 5%-9%	
		(e) 1%-4%	
		(f) 0%	
23	What method do you use in shelling your maize?	(a) maize Sheller	
		(b) beating with sticks	
		(c) hand shelling	
		(d) others (specify)	
24	What materials do you use to ensure cleanliness and reduced scattering of maize during shelling?	(a) tarpaulin	
		(b) bare ground	
		(c) other material (specify)	
25	How can you rate the percentage of maize grain lost during shelling?	(a) beyond 50%	
		(b) 30%-49%	
		(c) 10%-29%	
		(d) 5%-9%	
		(e) 1%-4%	
		(f) 0%	
26	What materials do you use for packaging your maize grains after shelling?	(a) traditional gunny bag	

		(b) hermetic storage (specify)	
		(i) plastic silo	
		(iii) super grain bag (multi-layer polyethylene storage bag)	
		(ii) metallic silo	
		(c) others (specify)	
27	Do you have a special facility for storing your packaged maize?	(a) yes	
		(b) no (specify where you store)	
28	If yes, and you use traditional gunny bags or super grain bags, what do you use to control ground moisture uptake by maize?	(a) pallets	
		(b) logs	
		(c) stones	
		(d) others (specify)	
29	What method do you use to keep away pest from your storage facility?	(a) fumigants	
		(b) others (specify)	
30	For what period do you store your maize before selling it off?	(specify)	
31	Where/how do you market your maize?	(a) traders find me on my farm	
		(b) I take it to buyers at their stores	
		(c) others (specify)	

32	How many kgs of maize did you sell off in your last harvest?	(specify)	
33	How much did you sell each kg?	(specify)	
34	Do you know any maize grain quality parameter specifications from any organization?	(a) yes (specify)	
		(b) no	

SECTION C: Production costs

State the amount of money spent on each of the following activities. Where not applicable leave it blank.

COSTS	AMOUNT (SHS)
<u>Fixed costs</u>	
Land purchase/hiring	
Crib construction	
Ware house/store construction	
Tractor	
Bicycle	
Auto mobile trailer	
Other fixed costs (specify below)	
.....	
.....	
.....	
.....	
.....	

.....	
<u>Variable costs</u>	
Land clearing	
1 st ploughing	
2 nd ploughing	
Fuel	
Purchase of seeds	
Purchase of fertilizers	
String	
Planting	
1 st weeding	
2 nd weeding	
Guarding against pests like baboons	
Transportation	
Tarpaulins	
Shelling	
Packaging materials	
Packaging	
Ware house storage	
Other variable costs (specify)	
.....	
.....	
.....	
.....	
.....	

SECTION D: Post-harvest handling at traders/store owners' level

Please **TICK** the response most appropriate to you and **specify** where requested to do so.

	Question	Alternative	Tick or specify
35	What is your position in this enterprise?	(a) director	
		(b) marketing manager	
		(c) quality controller	
		(e) others (specify)	
36	Where do you buy your maize?	(specify)	
37	What kind of materials do you use in packaging your maize for storage	(a) traditional gunny bag	
		(b) Hermetic storage materials (specify)	
		(i) plastic silo	
		(ii) metal silo	
		(iii) super grain bag	
		(C) others (specify)	
38	If (a) or (b.iii), do you have pallets in your store?	(a) yes	
		(b) no	
39	Do you fumigate your store?	(a) yes	
		(b) no	
40	For what period do you store your maize before selling it off?	(specify)	
41	Do you know any grain standards from any organization that you work towards achieving?	(a) yes (specify)	
		(b) no	
42	What are the causes of post-harvest loss in your store?	Tick multiple options (a) insects	
		(b) rodents	

		(c) Environmental factors	
		(d) thieves	
		(e) others (specify)	
43	Identify one major cause of post-harvest loss from those identified above and rate the amount of loss it causes to your business.	(cause)	
		(a) beyond 50%	
		(b) 30-49%	
		(c) 10-29%	
		(d) 5-9%	
		(e) 1-4%	
		(f) 0%	
44	How much maize did you bulk up in your last trading period?	(specify in k.gs/tones)	
45	How much did you buy each kilogram?	(specify in shillings)	
46	How much maize did you sell off at the end of your trading period?	(specify in k.gs or tones)	
47	How much did you sell each k.g?	(Specify in shillings)	
48	For what period have you been in the maize business?	(specify in years)	

SECTION E: Trading/production costs

Please state the amount of money spent on each of the following activities. Where not applicable, leave it blank.

COSTS	AMOUNT (SHS)
<u>Fixed costs</u>	
Store construction	
Purchase of pallets	

Truck purchase	
Weighing scale	
Silo construction	
Others (specify below)	
Variable costs	
Fuel	
Transport	
Labour	
Packaging materials	
Truck maintenance	
Fumigation	

END

Thanks for attending to my questions.

God bless you.

